

## Differentiating the coil geometry with respect to the plasma boundary

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The task of designing the geometry of a set of current-carrying coils that produce the magnetic field required to confine a given plasma equilibrium is expressed as a minimization principle, namely that the coils minimize a suitably defined error expressed as a surface integral, which is recognized as the quadratic-flux. A penalty on the coil length is included to avoid pathological solutions.

A simple expression for how the quadratic-flux and length vary as the coil geometry varies is derived, and an expression describing how this varies with variations in the surface geometry is derived. These expressions allow efficient coil-design algorithms to be implemented, and also enable efficient algorithms for varying the surface in order to simplify the coil geometry.